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Oral Epidemiology

Validation of Persian rapid estimate of adult literacy in dentistry

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Abstract

Aim: The aim of the present study was to establish the psychometric properties of the Rapid Estimate of adult Literacy in Dentistry-99 (REALD-99) in the Persian language for use in an Iranian population (IREALD-99).

Methods: A total of 421 participants with a mean age of 28 years (59% male) were included in the study. Participants included those who were 18 years or older and those residing in Quazvin (a city close to Tehran), Iran. A forward–backward translation process was used for the IREALD-99. The Test of Functional Health Literacy in Dentistry (TOFHLiD) was also administrated. The validity of the IREALD-99 was investigated by comparing the IREALD-99 across the categories of education and income levels. To further investigate, the correlation of IREALD-99 with TOFHLiD was computed. A principal component analysis (PCA) was performed on the data to assess unidimensionality and strong first factor. The Rasch mathematical model was used to evaluate the contribution of each item to the overall measure, and whether the data were invariant to differences in sex. Reliability was estimated with Cronbach's α and test–retest correlation.

Results: Cronbach's alpha for the IREALD-99 was 0.98, indicating strong internal consistency. The test–retest correlation was 0.97. IREALD-99 scores differed by education levels. IREALD-99 scores were positively related to TOFHLiD scores ($rh = 0.72$, $P < 0.01$). In addition, IREALD-99 showed positive correlation with self-rated oral health status ($rh = 0.31$, $P < 0.01$) as evidence of convergent validity. The PCA indicated a strong first component, five times the strength of the second component and nine times the third. The empirical data were a close fit with the Rasch mathematical model. There was not a significant difference in scores with respect to income level ($P = 0.09$), and only the very lowest income level was significantly different ($P < 0.01$).

Conclusions: The IREALD-99 exhibited excellent reliability on repeated administrations, as well as internal consistency. The IREALD-99 can be used for the basic screening of oral health literacy among the Iranian population.

Introduction

The World Health Organization, in its definition, ascertains the importance of health literacy, which determines an individual's access to health information and the effective use of that information in promoting and maintaining good health.[1] Health literacy is described as the currency for improving the quality of health and health

care.[2] Health literacy of an individual is characterized by various skills and abilities, including word recognition, reading comprehension, communication proficiency, and conceptual knowledge.[3–5]

Health literacy in dentistry is defined as "the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate oral health decisions".[6] Oral health literacy is dynamic in nature; an interplay between culture and society, the health system, education system, and oral health outcomes,[3,7] and might also vary depending on the medical problem being treated and the health-care provider.[3] Low dental health literacy is described as "the silent health epidemic"[8], and is "a potential barrier to effective prevention, diagnosis and treatment of oral disease".[9] Moreover, poor oral health literacy does not only have its effect at an individual level, but also at community level by contributing to disease, which results in economic burden on the community.[10] Measuring dental health literacy is useful, both at the individual level in dental clinics and at the population level in public health research, which helps in improving patient–provider communication and devising interventions to effectively improve dental health, respectively.[11]

Most of the literature on oral health literacy comes from the USA. The Institute of Medicine recognizes oral health literacy as a matter of national interest, which is evident from two of its reports. In addition, health literacy is also one of the objectives of the Department of Health and Human Services, Healthy People 2020.[12] However, a recent report from the Institute of Medicine's "Health literacy efforts outside of the United States" demonstrated that health literacy is no longer a US-only issue, and is widespread around the world.[13] Given the importance of measuring oral health literacy, several instruments have been developed in recent years to evaluate various dimensions of health literacy, ranging from word recognition to conceptual knowledge. The word-recognition oral health literacy instruments, Rapid Estimate of Adult Literacy in Dentistry (REALD)-30 and REALD-99, have been developed based on an already-existing reading recognition test used in medicine, the Rapid Estimate of Adult Literacy in Medicine (REALM), whereas instruments, such as the Test of Functional Health Literacy in Dentistry (TOFHLiD) and Oral Health Literacy Instrument have been developed based on reading comprehension levels used in Test of Functional Health Literacy in Adults.[14–19] Recently, Macek and colleagues introduced the Comprehensive Measure of Oral Health Knowledge, which incorporated the measurement of communication skills and non-numeric conceptual knowledge in oral health literacy instrument.[5]

Most of the oral health literacy instruments have been developed for use in English-speaking countries, which are the developed nations, while very few instruments have been developed in other contexts, such as Oral Health Literacy Assessment in Spanish, Hong Kong Oral Health Literacy Assessment Task for Paediatric Dentistry, and Hong Kong Rapid Estimate of Adult Literacy in Dentistry (HKREALD).[20–22]

There is a need to develop oral health literacy instruments for non-English-speaking populations in developing countries where the burden of oral disease is greater. Therefore, we aimed to develop an Iranian version of the word-recognition instrument (IREALD-99), which has been found to be valid and reliable.[22] Word-recognition instruments are also simple and easy to administer.[22] In the present study, the psychometric properties of the READL-99 in Persian language for use in an Iranian population (IREALD-99) was evaluated.

Materials and methods

The present study was performed between April 2013 and September 2013. The participants of the study were adults who resided in Qazvin (a city near Tehran), Iran. In Iran, health-care and public health services are provided through a nation-wide network. This network is a multitiered system that spans both urban and rural areas. The health center is considered a level of care that covers a population of 5000–15 000 people. Each urban health center keeps health records of all catchment area populations. Qazvin has 32 urban health centers. Ten urban health centers were selected randomly (simple random sample) for the present study. Fifty eligible adults were randomly selected (simple random sample) from health records from each urban health center.

A total of 500 adults who were eligible were approached via telephone and were invited to participate in the study. Inclusion criteria were being older than 18 years old, being able to read and write Persian, and agreeing to participate. Participants who were not able to read and write Persian, had vision and hearing problems, and had cognitive impairment were excluded from the study.

Translation procedure

The aim of the translation procedure was to create a translated version in the Persian language that is both conceptually equivalent to the original and easily understood by Iranian people. A forward–backward approach was performed to translate and adapt the IREALD-99 into the Persian language. For the first step, two translators independently translated the questionnaire into Persian.

Afterwards, the project manager (AP) compared the translations and reconciled discrepancies. Two translators, who were native English speakers and were fluent in the Persian language, independently translated the interim Persian version into English. The translators were not aware of the English original version. The project manager (AP) compared the English translations with the original questionnaire and reconciled discrepancies. The Persian language was piloted on 12 adults to identify and solve any potential problems in translation (e.g. wording).[23,24]

Measures

Sociodemographic measures

Sociodemographic factors, including age, sex, marital status, educational level, and monthly income, were collected using a self-reported questionnaire.

Self-perceived oral health status

A single item was used to assess adults' perception of their oral health status. Participants were asked to indicate their oral health status on a rating scale ranging from 0 (bad) to 5 (excellent).

Rapid estimate of adult literacy in dentistry-99

The REALD-99 has a list of 99 common dental words with various degrees of difficulty. This instrument should be read aloud in a structured interview. A correct response of word is rated 1, while pauses, hesitations, and repetitions are rated 0. The total REALD-99 scores range from 0 (low literacy) to 99 (high literacy).[15]

Test of functional health literacy in dentistry

The TOFHLiD is an instrument that assesses functional oral health literacy across populations. It consists of two sections; a 68-item reading comprehension test and a 12-item numerical ability test. The reading comprehension section for TOFHLiD consists of three passages about follow-up instructions for a caregiver following the application of fluoride varnish to their teeth, consent for dental treatment, and a description of Medicaid rights and responsibilities. The numeracy section has 12 questions related to four topics: instructions for fluoridated toothpaste use (five questions), a dental clinic appointment (three questions), and bottle prescription labels for fluoride drops (two questions) and fluoride tablets (two questions). The TOFHLiD scores range from 0 to 100, with higher scores indicating higher oral health literacy.[17,25]

Procedure

The study aim was explained to participants, who were then asked to sign an informed consent form. The participants completed the baseline questionnaire that contained questions related to sociodemographic factors and TOFHLiD. A structured interview was conducted by two interviewers, where the participants were asked to read aloud the words in Persian (REALD-99). Two weeks later, the participants were interviewed again. The study was approved by the ethics committee of Qazvin University of Medical Sciences.

Statistical methods

A principal component analysis (PCA) was performed to determine if there was a strong first factor and whether the data were unidimensional. Analysis was performed with the Psych package in R 3.0.2.[26,27] To determine the number of components to extract, the eigenvalues of the $k \times k$ correlation matrix of the variables were used. Each component is associated with an eigenvalue; the first principal component with the first eigenvalue (the largest), the second principal component with the second eigenvalue (the second largest), and the others follow suit. A scree test was performed that plotted eigenvalues against their principal components. The Kaiser-Harris criterion of retaining eigenvalues >1 was used to determine the number of components to retain. Eigenvalues <1 indicate that the component explains less variance than that contained in a single variable. This process allowed us to determine how many factors to retain in the PCA.[28]

The polytomous Rasch model was used to reveal the contribution of each item to the instrument, specifically to identify items that were redundant (yielding small fit statistics) and those demonstrating excessive variance (large fit statistics). Further, the Rasch analysis was used to compare item statistics between male and female cohorts to assess whether the items were invariant to differences in sex. Items that are invariant should have less than a 0.50 logit difference between sexes. The rating scale instrument quality must include the following if the rating is to be good: (a) item model fit, mean range square range extremes between 0.5 and 2.0; (b) person and item reliability estimates >0.81; (c) person separation between 3.0 and 4.0; (d) <2% of scores, not maximum extreme or minimum extreme (all adults getting the question right or wrong); and (e) percentage of variance in data explained by measures should be between 60% and 70%.[29] The Rasch analysis was performed with Facets 3.68.01.[30] Facets was selected as it is able to analyze polytomous data, but also eases the analysis when considering the additional factor of sex. With Facets, the model

statement could be expanded to include adults, items, and sex, rather than just person and items. Different outputs could then be easily generated by simply turning the sex facet to female or male.

Assessments of reliability and validity for iranian rapid estimate of adult literacy in dentistry-99

Reliability

Internal consistency of the data was estimated with Cronbach's alpha.[31] The 95% confidence interval (CI) was calculated. Cronbach's alpha was included as it is ubiquitous in the industry. All 99 items were correlated to the summed score, and the average correlation to the summed score was calculated. To assess the stability of the IREALD-99 across times, the intraclass correlation coefficient (ICC) with corresponding 95% CI was computed.[32] In addition to the ICC, kappa statistic was also computed to assess the extent of agreement between the two assessments.

Concurrent validity

Concurrent validity was investigated by comparing the IREALD-99 across the categories of education and income levels. When appropriate, ANOVA was performed for the same categories.

Convergent validity

Convergent validity was assessed by evaluating the correlation between IREALD-99 and TOFHLiD.[15] Spearman's rank correlation coefficient was computed to assess the correlation between IREALD-99 and TOFHLiD.

Results

Of the 500 adults approached to participate in the present study, 79 were not willing to provide informed consent, and therefore, were excluded from the study. Subsequently, a total of 421 participants participated in the study, with a response rate of 84.2%. The mean age of the adults was 27.88 ± 8.55 years, with the majority male (59%). Demographic information is provided in Table 1.

Reliability

Cronbach's alpha coefficients for the IREALD-99 were higher than 0.70 ($\alpha = 0.98$, 95% CI = 0.97–0.98). The repeatability of the IREALD-99 over 2 weeks was assessed using ICC. The results indicated that the 2-week test–retest reliability of the IREALD-99 was acceptable, with an ICC of 0.97 (95% CI = 0.96–0.97). Values for ICC $r < 0.40$, 0.41–0.60, 0.61–0.80, and 0.81–1.00 were reflected poor, fair, moderate, and good agreement, respectively.

Table 1. Demographic data of the 421 participants

Characteristic		Participants (%)
Sex	Male	59.0%
	Female	41.0%
Income ($US)	<$500	45.4%
	$500–$700	24.2%
	>$700	21.6%
	Not reported	8.8%
Marital status	Single	47.0%
	Married	53.0%
Mean age (standard error)	Males	28.4 years (0.59)
	Females	27.2 years (0.60)
Education	Primary	4.0%
	Intermediate	5.0%
	Secondary	26.0%
	University (graduated)	60.0%
	Postgraduate	5.0%

Item reduction

The scree test in Figure 1 suggests retaining three components. The first component is approximately five times the second component and nine times the third. The second component is approximately twice the third. An unrotated PCA revealed that the first three factors explained 43% of the variance. All the components in Figure 1 were above the Kaiser–Harris criterion. Despite this, three components were retained. The PCA with varimax rotation explained 89% of the variance in three rotated components: component 1 = 47%, component 2 = 42%, and component 3 = 11%. Component 1 consisted of 51 words; the 10 with the highest factor loading included Q65 (0.80) = suture, Q4 = tooth, Q21 = cancer, Q46 = diabetes, Q49 = infection, Q2 = sugar*, Q32 = denture*, Q3 = Smoking*, Q64 = prescription, and Q92 (0.70) = hyperemia*. Component 2 consisted of 55 words, the 10 with the highest factor loadings included

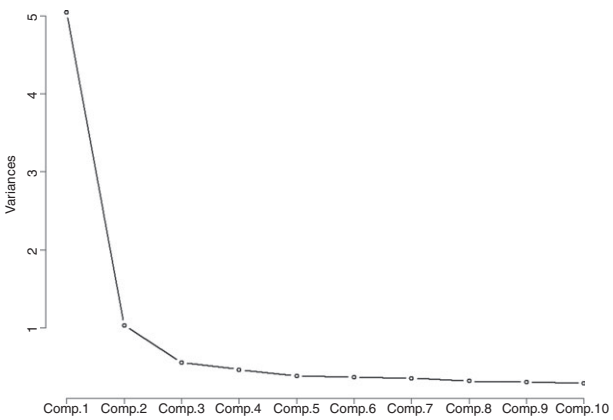

Figure 1. Scree plot of eigenvalues versus principal components. Three components are suggested.

Table 2. Rasch output: fit statistics

Items	Model		Infit mean square	Infit ZSTD	Outfit mean square	Outfit ZSTD
	Measures	Standard error				
Brush	−3.17	0.33	1.39	1.5	6.99	2.7
Toothpaste	−2.52	0.28	1.55	2.4	4.70	2.6
Gingival	−1.35	0.20	1.02	0.2	4.48	4.3
Diet	−2.68	0.29	1.21	1.0	4.47	2.4
Fracture	−1.23	0.20	0.86	−1.1	3.81	3.9
Bacteria	−1.27	0.20	0.93	−0.5	3.56	3.6
Bleach	−0.94	0.18	0.95	−0.3	3.42	4.1
Dentist	−2.37	0.27	0.97	−0.1	3.05	1.9
Caries	−2.30	0.26	1.01	0.1	2.48	1.6
Bite	−0.17	0.16	1.18	1.9	2.14	3.4

ZSTD, standardized fit statistic.

Q45 (0.70) = deductible, Q27 = pulp*, Q19 = implant, Q95 = hypoplasia*, Q34 = enamel*, Q75 = fluorosis, Q86 = transmissibility, Q44 = sedation, Q72 = periodontal*, and Q22 (0.60) = braces*. Component 3 consisted of six questions: Q47 (0.52) = discolored, Q63 (0.50) = cyst, Q55 (0.45) = nutrition, Q90 (0.45) = dentition*, Q52 (0.42) = panoramic, and Q56 (0.40) = inflammation. The "*" indicates that the question also appears in READ-30.

Rasch analysis: item quality

One of the infit values was outside the range designated by Fisher as being good (between 0.5 and 2.0). Only one of the 99 items reported an infit mean square of >1.5. That item was number 30, toothpaste. The output from Facets for item fit that presents the 10 worst fitting items is shown in Table 2. The first column is the item difficulty, the second column is the standard error, the third is the item infit mean square, the fourth is the infit mean square expressed as a z-score, the fourth and fifth are outfit mean squares, and the sixth is the item itself. Only toothpaste had an infit mean square >1.5, as shown in Table 2, that, thus showing more variance than desired. All other items were close to 1.0, which was close to the variance desired.

Internal consistency, as estimated by Cronbach's alpha, was 0.98 (95% CI: 0.97–0.98). The person separation reliability estimate was 3.85, and the item separation reliability estimate was 9.15, easily meeting the quality criteria of good by Fisher. Seventeen individuals (4%) scored correct on all the questions/items and reached the maximum score. No individual got all the questions wrong. For this criterion, the instrument only reached the fair rating by Fisher. The variance explained by Rasch measures was 47.54%, again, only reaching the fair rating by Fisher. Perhaps the most striking indication that the instrument reasonably matched the Rasch model is shown in Figure 2, which demonstrates that the empirical data and mathematical model had a close fit, except for the lower end of the scores (5–15% correct).

The males in the sample had a mean person measure of 2.01 and a standard deviation of 2.04. Females had a mean person measure of 2.45 and a standard deviation of 2.19. The item with the greatest difference between the sexes was toothpaste (males: –5.05, females: –1.23). This item also showed the most variance (infit mean square of 1.55, outfit mean square of 4.70). The 10 items showing the greatest absolute difference between the sexes were 30, toothpaste (3.82); 14, filling (2.08); 13, oral (1.95); 66, radiograph (1.75); 90, dentition (1.70); 1, bite (1.60); 93, analgesia (1.46); 81, halitosis (1.44); 16, snacking (1.36); and 47, discolored (1.31). In all, 39 items had Rasch measures differing more than 0.50 between the sexes (data not shown).

Concurrent validity of the Iranian rapid estimate of adult literacy in dentistry-99

The participants' scores on each item were added to arrive at a summed score. Information on participants'

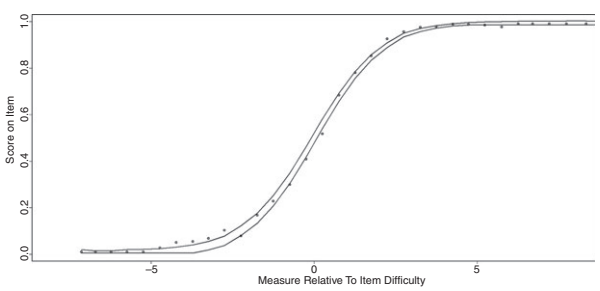

Figure 2. Average item characteristic curve for the 99 items. Solid line represents the mathematical model, x represents empirical data, and thin lines represent the 95% confidence intervals for the data.

Table 3. Comparison of IREALD-99 scores in relation to income levels

Income ($US) level (sample size)	IREALD-99 score			
	Mean (95% confidence interval)	Standard deviation	Standard error	*P*-value
<$500 (191)	73.4 (70.2–76.6)	22.4	1.62	0.09
$500–$700 (102)	75.1 (71.6–78.6)	18.3	1.81	
>$700 (91)	78.0 (73.4–82.6)	22.2	2.33	
Unknown (37)	71.0 (64.9–77.1)	09.1	3.13	

IREALD-99, Iranian rapid estimate of adult literacy in dentistry-99.

summed scores for each of the income levels is provided in Table 3. ANOVA revealed no statistical difference for IREALD-99 scores between income levels ($P = 0.09$).

Information on the influence of education on IREALD-99 scores is provided in Table 4. There were significant differences ($P < 0.01$) in total IREALD-99 scores between the participants depending on education levels. The relationship was not linear, as shown in Table 4. However, participants with the lowest education level (primary education) had the poorest literacy scores.

Convergent validity of the Iranian rapid estimate of adult literacy in dentistry-99

As expected, the IREALD-99 scores were positively related to the TOFHLiD scores ($rh = 0.72$, $P < 0.01$). Furthermore, IREALD-99 was positively correlated with self-perceived dental health status ($rh = 0.31$, $P < 0.01$) (data now shown). The descriptives for IREALD-99 and TOHFLiD are presented in Table 5.

Discussion

READ-99 has been developed as a comparable dental literacy instrument to REALM, which is a helpful instrument for health practitioners and researchers to evaluate health literacy.[15] Although word-recognition literacy instruments, such as REALD-99, lack comprehensiveness, REALD-99 is quick and easy to administer, much like REALM, which is known as the most easily administered tool for assessing health literacy in English.[33] To the best of our knowledge, REALD-99 has never been evaluated for cross-cultural adaptability. However, the shorter version of REALD-99, that is, REALD-30, has been recently developed in Chinese and was found to be valid and reliable in evaluating dental health literacy in a Hong Kong population.[22]

Although, REALD-99 was not evaluated for reliability on repeated administration,[15] we attempted to observe the reliability of Persian version of REALD-99 after 2 weeks, which we found to be excellent, with an ICC of 0.97. In addition, the internal consistency was also substantial, more than that observed by the developers of REALD-99.[15]

The overall IREALD-99 scores differed with the participants' educational level, whereas it was unable to discriminate the income categories. This is in accordance with a study that observed a strong relationship of health literacy with educational level, and demonstrated a weak relationship with income, as income has very little effect on prior knowledge.[34] However, we did not observe a definite trend for the relationship of IREALD-99 scores with educational level. IREALD-99 was only able to discriminate

Table 4. Comparison of IREALD-99 Scores in relation to level of education

Level of education (sample size)	IREALD-99 score			
	Mean (95% confidence interval)	Standard deviation	Standard error	*P*-value
Primary ($n = 16$)	45.1 (28.7–61.5)	33.4	8.35	0.009
Intermediate ($n = 22$)	79.7 (74.7–84.7)	12.0	2.55	
Secondary ($n = 105$)	70.4 (66.0–74.8)	22.9	2.23	
University (graduated) ($n = 246$)	77.7 (75.4–80.0)	18.8	1.20	
Postgraduate ($n = 20$)	71.5 (65.6–77.5)	68.5	3.06	
Unknown ($n = 12$)	81.2 (69.0–73.4)	21.6	6.23	

IREALD-99, Iranian rapid estimate of adult literacy in dentistry-99.

Table 5. Descriptive statistics and reliability of the IREALD-99 and TOFHLiD

	Mean	SD	Minimum	Maximum	ICC	Cronbach's alpha
IREALD-99	74.56	21.20	5	99	0.96 (0.96–0.97)	0.98
TOFHLiD	83.12	17.29	12	92	–	0.94

IREALD-99, Iranian rapid estimate of adult literacy in dentistry-99; TOFHLiD, test of functional health literacy in dentistry.

individuals with primary education from others. Reading for leisure or work has also been reported to influence health literacy,[35] which might be less common in those who are just primary educated. This would have masked the direct influence of other categories of education on oral health literacy. Literature also suggests that health literacy does not exhibit a linear gradient with the increase in education, and health literacy plays an importance role in those with a lower education than those with a higher education.[35,36] However, the association of education with oral health literacy is partly in accordance with previous studies on oral health literacy.[37–40]

On the contrary, a previously-published study reinstated that health literacy is not all about educational level, and this reason itself was the driving force for developing health literacy instruments, despite education attainment being proposed by a few as a proxy measure of health literacy.[14] Nevertheless, educational level should be used cautiously as an alternative to health literacy evaluation, as it does not accurately reflect an individual's ability to understand and use written information.[14]

IREALD-99 exhibited good convergent validity and it was also significantly correlated with other dental health literacy instrument, such as the TOHFLiD. In addition, IREALD-99 scores were significantly correlated with self-perceived oral health status. This is supported by a recent study from Iran that observed low oral health literacy level to be a predictor for poor self-reported oral health, independent of education and other socioeconomic determinants.[7] A US study also demonstrated that participants who self-reported very good oral health status were more likely to have better oral health literacy scores than those who reported good/fair/poor oral health status.[37]

Self-rated oral health has been previously used in evaluating the construct validity of oral health-related quality of life instruments,[41] and has also been used for evaluating the convergent validity of REALD-99 in English.

All but one item had a good fit to the Rasch model. The lesser-fitting items in the Rasch analysis were words that are of common usage, and there was only one word (toothpaste) that had infit mean square range beyond 1.5. Empirical and mathematical data had a close fit, except for the lower end of the scores. This is common in both Rasch analysis and classical test theory analysis (CTT). In CTT, however, the standard error is only estimated for the mean and not for each individual item and person. The small number of participants scoring at the extremes increases the wider confidence intervals seen in Figure 2.

To the best of our knowledge, the present study is the first to appraise the performance of the English or translated REALD-99 instrument across sexes. IREALD-99 did not demonstrate equivalency between sexes. Rasch measures varied between sexes for 39 items. Females had higher overall IREALD scores and had higher Rasch estimates for snacking, halitosis, analgesia, radiograph, and filling (females had lower raw scores for these items). Males had higher Rasch estimates for toothpaste, oral, dentition, bite, brush, and porcelain. These sex differences were not tested by the developers of REALD-99, probably because of less male participants (12%) in their study.[15] Females scoring more than males on oral health literacy is in line with previous studies from Iran.[42] The rationale for this finding has been attributed to greater exposure of Iranian females to audio-visual media, which is one of the most common sources of oral health-related information in Iran.[42]

Sex distribution in the present study was approximately equal, while in previous studies of REALD, females constituted a major proportion of the study sample. Although the study sample was representative and of moderate size compared to smaller sample sizes and convenience sampling procedures used in previous validation studies of REALD, the present study is not free of limitations. One limitation of our study is that we relied on self-reported oral health status and did not relate the oral health literacy scores to clinical outcomes, as oral clinical assessment was not done.

Conclusion

IREALD-99 exhibited excellent reliability on repeated administrations and also internal consistency. In addition, it showed positive correlation with TOHFLiD and self-rated oral health status, thus exhibiting good convergent validity. IREALD-99 scores differed across the categories of educational attainment, but not income. IREALD-99 can be used for the basic screening of oral health literacy among the Iranian population.

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